Confederated Tribes and Bands
of the Yakama Nation

Established by the
Treaty of June 9, 1855

October 19, 2015

Amy Legare, Chair
National Remedy Review Board (NRRB)
U.S. Environmental Protection Agency (EPA)
1200 Pennsylvania Avenue, NW
Mail Code 5204P
Washington, DC 20460

Dear Ms. Legare:

Thank you for the opportunity to submit comments regarding cleanup of the Portland Harbor Superfund Site in anticipation of the Proposed Plan and Records of Decision (ROD) expected to be issued next year under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

The Willamette River has been an important food gathering area for people of the Yakama Nation since Time Immemorial, and our members still depend on this river to provide the culturally important Asúm eel (Lamprey) for traditional ceremonies and subsistence. But the Willamette River is also the largest industrialized tributary and source of contamination to the Columbia River. The main stem Columbia is the most important Treaty fishing area for the people of the Yakama Nation, and the tribe fought for two decades in the U.S. District Court in Oregon to co-manage the river's resources and protect its fishing rights and way of life. It has also invested many years of effort and many millions in federal and state funds to increase both wild fish recovery and fish hatchery production throughout the Columbia Basin. Survival of many of these fish that rear as juveniles in the Lower Columbia River will continue to be under threat from Portland Harbor contaminants if the proposed remedial actions are inadequately protective. Preliminary damage assessments have shown that Willamette releases have already substantially contributed to injury to fish in the Lower Columbia. For this reason it is our goal to see that all impacts from Portland Harbor contaminants to the Columbia River are eliminated.

We are stressing the importance of protective and permanent remedial actions at the site. Active remediation by removing contaminated sediment from the lower Willamette River must be the preferred alternative to ensure that the river effectively reaches the long term remedial goals. The lower Willamette River must be restored to support healthy natural resources and to produce fish that are safe for human consumption, in order to protect the Columbia River.

The Yakama Nation's compliance objectives for the cleanup of Portland Harbor include the following:

1. Complying with the Yakama Treaty, including the Yakama people's right of full access to cultural resources within their aboriginal territory, including the Willamette River.
2. Protecting the health of Yakama Nation tribal members and the environment so that the resources of the Columbia and Willamette Rivers are safe for all exposure scenarios and tribal uses.
3. Eliminating sources of contaminants causing harm to Columbia River resources.

4. Cleanup decisions that follow the CERCLA RI/FS process and requirements through finalization and approval of documents prior to development of the Proposed Plan for a final ROD.

5. Cleanup actions must comply with all applicable and relevant federal and state regulatory requirements.

6. Cleanup actions must be complete, permanent, and protective. Actions must not rely on long-term institutional controls to address persistent and bioaccumulative toxic wastes.

Based on our review of the Draft Feasibility Study, it is clear that none of the proposed remedial alternatives meet these objectives, and we would like to suggest that EPA explore and develop an additional option beyond Alternative G that would achieve them. The Yakama Nation is prepared to assist EPA in advancing these cleanup goals and we expect our federal trustee to take decisive and aggressive action to ensure that our resources are restored and protected for future generations of Yakama people.

Attached is a summary of technical issues related to the Portland Harbor Superfund cleanup. The Yakama Nation believes there are serious deficiencies in a cleanup process that relies on long-term monitoring and maintenance of caps and barriers in the active river channel and fish consumption advisories.

Thank you for your consideration. I look forward to discussing the Yakama Nation's concerns and recommendations regarding Portland Harbor cleanup with the NRRB.

Sincerely,

Paul J. Ward, Manager
Yakama Nation Fisheries

Attachment

cc: Dennis McLerran, Regional Administrator, EPA Region 10

Yakama Nation Technical Issues for Portland Harbor Cleanup Decisions
EPA National Remedy Review Board
October 2015

The U.S. Environmental Protection Agency (EPA) anticipates issuing a Record of Decision (ROD) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) for the Portland Harbor Superfund Site (Site) next year. The Confederated Tribes and Bands of the Yakama Nation appreciate the opportunity to discuss concerns about Portland Harbor with the EPA National Remedy Review Board, including this summary of technical issues and recommendations that are pertinent to the cleanup decisions being made for the site.

We believe that the cleanup alternative selected must protect the health of Tribal and other people who consume fish and should eliminate sources of contaminants causing harm to the Columbia River and its natural resources. In particular, the Yakama Nation is concerned with the polychlorinated biphenyls (PCBs) and other persistent pollutant contamination in the Willamette River, because these contaminants are not likely to diminish by natural recovery. Therefore, a more active remediation approach is warranted in the more highly contaminated areas and throughout the site.

Of the alternatives presented in the draft Feasibility Study, Alternative G removes the most sediment contamination; however, Alternative G does not provide a post-construction condition that is protective of human health and the environment without implementation of institutional controls, including fish consumption advisories, in perpetuity. Alternative G will not remediate contaminated sediments to background concentrations, and unacceptable residual risks to human health and the environment will remain.

The cleanup at Portland Harbor is a long term investment in community and ecological health. In order to sustain a successful remedy that is protective of human health and the environment, EPA should implement a comprehensive and integrated cleanup approach that addresses the complexity of the contaminant challenges. This will require participation of EPA and State of Oregon programs to identify, plan, implement, and monitor activities necessary to ensure compliance with environmental laws and regulations. This is of particular importance to ensure that sources within and upstream of Portland Harbor do not cause recontamination or otherwise diminish the efforts to remediate Portland Harbor.

Yakama Nation recommends that EPA undertake a cleanup of Portland Harbor that is protective and permanent. The key features include:

1. An Alternative “G Plus” cleanup for the Portland Harbor Superfund site cleanup that is a broader and more intense implementation of the FS Alternative G by removal of more contaminated sediment and with less reliance on capping and natural recovery.
2. A comprehensive approach to addressing the contaminants in the Willamette River watershed by implementing a coordinated multi-program effort using EPA and State of Oregon authorities.
3. Evaluation of long-term effectiveness of the selected remedy by monitoring conditions upriver and downriver of the Site before, during, and after implementation of the selected alternative.

The contamination from the Portland Harbor Superfund Site does not stop at the site boundary. Harmful and toxic pollutants from the Willamette River are carried into the Columbia River and have been found in salmon below the confluence of these two rivers. Federal, state, tribal, and many local partners are working to support the recovery of salmon and steelhead in the Lower Columbia River and its tributaries. Since 1978, Bonneville Power Administration has invested 2.68 billion dollars in anadromous fish recovery in the Columbia River watershed. Considerable resources (on the order of $200 million annually) are directed towards these efforts in order to abate the decline of these species and move toward their recovery. The effectiveness of the Portland Harbor Superfund Site cleanup is critical to support the recovery of salmon and steelhead (and other economically and culturally important species) in these waters.

Major Issues

The Yakama Nation does not believe that current alternatives being considered for the cleanup are adequately protective of Tribal people or Treaty resources. Superfund cleanups must be protective of the environment and human health, including tribal people. Key issues related to the Remedial Investigation, Feasibility Study, and cleanup process are listed below.

1. **The proposed remedies do not fully comply with the Treaty of 1855 between the Yakama Nation and the United States of America.** The Treaty, which reserves specific rights and resources for the Yakama Nation, should be acknowledged as an applicable or relevant and appropriate requirement (ARAR) or a “must comply” standard for cleanup decisions. This requirement includes the right to fully practice subsistence activities in Yakama usual and accustomed use areas. EPA’s cleanup should protect and not conflict with treaty rights.

2. **Using background sediments upstream from the Portland Harbor Site that are contaminated to set remedial action levels for the cleanup results in a remedy that will pose risk to human health and the environment.** The background concentrations are based on limited data collected from contaminated locations upriver from the Site. In addition, the background data were collected almost a decade ago and background concentrations are expected to decrease over time as inputs to the watershed are controlled.

3. **Adequate upland source control measures must be in place prior to the cleanup to protect the river from recontamination.** Source control will require effective coordination with the State of Oregon and the application of appropriate state and federal authorities, as well as continued monitoring of tributaries and receiving waters.

4. **There are many properties within the Portland Harbor Superfund Site that are ongoing sources of contamination from groundwater pathways.** The complexity of shallow groundwater flow over the entirety of the Site is a consideration. Because groundwater is a continuing source of contamination to the river, it should be carefully considered as part of the cleanup.

5. **Contaminants from background sources, upland sources, and groundwater pathways should be reduced to levels such that recontamination of the remediated Site does not occur.** EPA and the State of Oregon should coordinate activities, including enforcement as needed, to eliminate ongoing sources of contamination to the Willamette River.

6. **Human health and the environment must be protected, but none of the remedial alternatives evaluated in the Feasibility Study (FS) meet the protectiveness criteria without institutional controls, including limits on fish consumption in perpetuity.** At the completion of construction, none of the alternatives will meet the acceptable risk range. Since modeling to evaluate the effectiveness of the alternatives in reducing risk over the long-term was determined to be infeasible, there is no assurance that any of the alternatives will ever meet the criteria for protectiveness.

7. **None of the alternatives evaluated in the Feasibility Study will comply with ARARs.** Chemical-specific numeric human health and aquatic life water quality criteria and relevant State of Oregon narrative criteria will not be met with the cleanup alternatives evaluated.

8. **A perpetual fish consumption advisory will be needed following the implementation of any of the alternatives in order to protect fish consumers.** This fact demonstrates that the designated fishable use of the waters in the project area will be impaired following the cleanup.

9. **Releases from Portland Harbor are major contributors to the contamination of resources in the lower Columbia River.** To date, the EPA has failed to take into consideration the releases from the Site to the lower Columbia River. The RI and FS do not adequately use the data that were collected to discuss the loading and potential impacts to resources beyond the Site boundaries.

10. **Portland Harbor is contributing highly toxic PCBs, DDT, and polycyclic aromatic hydrocarbons (PAHs) and other pollutants to the Columbia River.** As a result, the health of juvenile salmon in the Columbia River are impaired by exposure to these contaminants. Pacific lamprey and sturgeon are also at risk from these toxic substances.

Specific Concerns

The human health risks from the Portland Harbor Superfund Site are largely driven by contaminants in the sediments that accumulate in fish and shellfish.

People interact with a river in numerous ways. The Portland Harbor is a diverse water way with both industrial, recreational, and cultural uses. The lower Willamette River provides opportunities for recreation (on-water and shore), fishing (recreational, subsistence), and is of cultural significance for tribal fishers—especially for their connection to the Pacific lamprey and the Chinook salmon.

The *Baseline Human Health Risk Assessment* (BHHRA) for Portland Harbor submitted as Appendix F prepared by the Lower Willamette Group (LWG, 2013) and included with the *Draft Final Portland Harbor RI Report* (EPA, 2015) estimated cancer risks from the consumption of fish and shellfish from the Site are generally orders of magnitude higher than other primary routes of exposure (direct contact with sediment and surface water). The health risks and non-cancer hazards from the consumption of fish and shellfish exceed the EPA point of departure for cancer risk of 1×10^{-4} and target hazard index (HI) of 1 harbor-wide and for each river mile. Consumption of resident fish species resulted in the greatest risk estimates. Non-cancer HI estimates for consumption of resident fish species are greater than 1 at all river miles. The highest non-cancer hazards are associated with nursing infants of mothers who consume resident fish from the Site.

The BHHA estimated the harbor-wide cancer risk and HI for the exposed populations:

- The estimated reasonable maximum exposure (RME) cancer risks are 4×10^{-3} (1 in 4000) and 1×10^{-2} (1 in 100) for recreational and subsistence fishers, respectively.
- Based on an evaluation of non-cancer risk, the estimated RME HI is 300 for recreational fishers and 1,000 for subsistence fishers.
- When resident fish consumption is evaluated, the estimated RME HI is 4,000 for breastfed infants of recreational fishers and 10,000 for breastfed infants of subsistence fishers.
- The estimated RME HI for tribal consumers of migratory and resident fish is 600 assuming fillet-only consumption, and 800 assuming whole-body consumption.

- The corresponding HI estimates for nursing infants of mothers, who consume fish, are 8,000 assuming consumption of fillet and 9,000 assuming consumption of whole-body fish.

PCBs are the primary contributor to risk from fish consumption within the Site. PCBs are also the primary contributors to the non-cancer hazard to nursing infants, primarily because of the bioaccumulative properties of PCBs and the susceptibility of infants to the developmental effects associated with exposure to PCBs. When evaluated on a river mile scale, dioxins/furans are a secondary contributor to the overall risk and hazard estimates, particularly at RM 6 and 7.

PCBS, dioxins/furans, PAHs and other persistent organic pollutants primarily reside in the highest concentrations in nearshore sediments and in locations proximal to local upland sources. High PCB concentrations are also found in riparian sediment, surface waters, mobile sediments, and in fish tissue samples in areas with elevated sediment concentrations. Numerous historical and/or current sources of PCBs and other persistent organic pollutants are likely to continue to negatively impact health risks and non-cancer health hazards for people who use the Site unless adequately addressed.

Evaluation of the distribution of contaminants demonstrates that ecological risk is an environmental threat at the Portland Harbor Superfund Site.

Numerous aquatic and aquatic-dependent organisms rely upon the environmental quality of the lower Willamette River. An estimated 1,520 acres of the Site are contaminated with sediments that exceed the ecological preliminary remedial goals (PRGs). Innumerable chemicals have been identified and observed throughout the Site. Of those, a total of 93 contaminants pose potentially unacceptable ecological risk (grouping individual PCBs, DDx [the pesticide DDT and derivatives], and PAH compounds reduces the number to 66) and have a negative impact on the site ecological health. The summary information included is from the LWG Appendix G, *Baseline Ecological Risk Assessment* (BERA, LWG 2013) included with the *Portland Harbor RI/FS Final Remedial Investigation Report* (EPA, 2015).

The BERA evaluated the nature and extent of health risks to organisms within the Site. The BERA evaluated the health of 13 groups of organisms that are part of the Lower Willamette River ecosystem, including plants, benthic invertebrates, amphibians, fish, birds, and aquatic-dependent mammals for both exposure and ecological effects. The BERA identified moderate and severe levels of toxicity clustered in several areas of the Site.

The BERA evaluation identified the following:

- The most ecologically significant chemicals of potential concerns (COPCs), contributing to levels of potentially unacceptable risk, are PCBs, PAHs, dioxins and furans, and DDT and its metabolites.
    - PCBs in mammals and birds
    - PAHs, dioxins and furans, and DDT and its derivatives (DDx) in benthic organisms
- Contaminants identified as posing potentially unacceptable risk with the largest number of lines of evidence (greater than three) include:

total PCBs	zinc	4,4’-DDT
copper	total toxic equivalents (TEQ)	dioxin/furan TEQ
total DDx	PCB TEQ	bis(2-ethylhexyl)phthalate (BEHP)
lead	benzo(a)pyrene	naphthalene
tributyltin (TBT)	cadmium	benzo(a)anthracene

- Risks to benthic invertebrates are clustered in 17 benthic sediment areas of concern.

- Sediment and transition zone water (TZW) samples with the highest hazard quotients (HQ) tend to be clustered in areas with the greatest benthic invertebrate toxicity.
- The combined toxicity of dioxins/furans and dioxin-like PCBs, expressed as total TEQ, poses the potential risk of reduced reproductive success in mink, river otter, spotted sandpiper, bald eagle, and osprey.

The BERA indicates through multiple lines of evidence that sediment contamination (with persistent organic pollutants [PCBs, PAHs, dioxins/furans, and DDT and its derivatives] and metals) pose a large unacceptable risk and on-going ecological threat to organisms within the Site. The adverse health of these organism and the overall ecological health at the Site expands to impact the health of surrounding human communities.

The Feasibility Study Alternatives will not achieve Remedial Action Objectives.

The FS developed seven (7) alternatives, designated A, B, C, D, E, F, and G to remediate the Site. The alternatives from A to G each remediate more contamination, therefore Alternative A, the no-action alternative, is the least protective and Alternative G is the most protective of the alternatives presented in the FS. All of the alternatives rely on monitored natural recovery (MNR), institutional controls, and source control to achieve the remedial action objectives (RAOs). None of the alternatives will achieve RAOs at the completion of the remedial action or meet the threshold criteria of protecting human health and the environment.

The FS did not use the Lower Willamette Group's hydrodynamic and sediment transport (HST) model and has concluded that the HST model predictions are inconsistent with the conceptual site model (CSM) for this site, as it shows significant concentration reductions occurring within the first 10 years. However, given that the majority of the contamination was released into the river 30-80 years ago and similar reductions have not been observed, the model results appear inconsistent with the empirical data collected during the RI.

Each alternative utilizes the following treatment technologies to varying degrees:

- <u>Dredging</u> Removal of contaminants through physical removal of contaminated sediment.
- <u>Capping</u> A physical barrier placed over contaminated sediment to prevent contact with contamination.
- <u>Monitored Natural Recovery</u> Relies on ongoing, naturally occurring processes to contain, destroy, or reduce the bioavailability or toxicity of contaminants in sediment. These processes may include physical (burial and sedimentation or dispersion and mixing), biological (biodegradation), and chemical (sorption and oxidation) mechanisms that act together to reduce the risk posed by the contaminants.
- <u>Enhanced Monitored Natural Recovery (EMNR)</u> Consists of a three to six inch layer of material used in thin layer cover placement with an activated carbon mixture to adsorb contaminants.
- <u>Institutional Controls (ICs)</u> Refers to non-engineering measures intended to affect human activities in such a way as to prevent or reduce exposure to hazardous substances, often by limiting land or resource use. These controls have no ability to reduce ecological exposures. At the site, ICs may limit human exposure by instituting fish consumption advisories and limiting other activities during and after implementation of the remedy.

It should be noted that none of the alternatives presented in the FS will achieve RAOs after implementation and all will require the use of long-term MNR. However, the FS states, "While the desire for explicit predictions of long-term outcomes is recognized, the ability to predict outcomes are currently unreliable." Therefore, "predicting declines in sediment concentrations and associated risks will only be evaluated in a qualitative comparative manner."

In the FS, a separate Remedial Action Level (RAL) was developed for the focused chemicals of concern (COCs) under each alternative. The RAL is the level of contamination remaining in the sediments after the remedial action is complete. The RALs for each alternative are presented in **Table 1** (attached).

A plan view of the combination of technologies for Alternative G is shown in FS **Figure 3.6-7a** (attached). As shown on **Table 2** (attached), Alternative G would provide the greatest risk reduction at the time the remedial action is complete and leave the least amount of contamination in the sediment, but not at levels that provide adequate protection of human health and the environment.

In order to achieve the RALs, the FS calculates the amount of area to be treated and dredge volume required for each alternative. A summary of these areas and volumes is presented in **Table 3** (attached), which shows that the area to be treated and dredge volumes increase with each more protective alternative. In addition, as shown on **Table 3**, the time for construction and cost increase with each more protective alternative.

The FS calculates the percent reduction of each focused COC at the end of the remedial action construction for each alternative. These reductions are displayed graphically in **Figure 1** (attached); showing that Alternative G achieves the greatest risk reduction for the focused COCs.

Background sediment concentrations should be reevaluated to adjust cleanup targets.

Background sediment concentrations in the Willamette River should be reevaluated (and cleanup targets should be adjusted) to be aligned with the representative level of ambient (natural and wide-spread anthropogenic contamination) concentrations of chemicals, not associated with the Site or historical and current point-sources of contamination, that would provide cleanup level targets that are appropriate for contemporaneous (at or close to the time of cleanup) environmental conditions.

Much of the site background data were collected nearly a decade ago with some samples collected as early as 1999 (samples were collected between eight and 16 years ago). Since this time, environmental conditions may have improved and may continue to improve as remedies are implemented. Measurements, especially for low level persistent organic compounds, have also improved analytically. New background data would provide greater assurance that appropriate concentrations of risk-driving contaminants are used in design, and address issues associated with elevated detection levels noted throughout the previous dataset for many organic analytes.

Background concentrations should be measured, preferably at regular intervals consistent with remedial design and construction, with improved analytical methods for persistent organic pollutants, like PCBs, which drive risk in sediments site-wide. Newer data should measure PCB congeners to provide a more robust and consistent data set. In addition, the data available currently were either incomplete or had inadequate detection limits for several compounds, such as TBT, dieldrin, and aldrin, such that background concentrations could not be determined.

Reductions in background contamination in upstream water bodies should be addressed by EPA through cross-program actions in cooperation with the State of Oregon to ensure compliance with the Clean Water Act.

"Achieving water quality goals and maintaining public health and environmental improvements at Superfund cleanups and other contaminated sediment sites requires cross-program collaboration."

February 12 Memorandum to Regional Administrators on Promoting Water, Superfund and Enforcement Collaboration on Contaminated Sediments (US EPA, 2015). Because upstream and upland sources and groundwater inputs contribute to this CERCLA site and are one reason for the inability to meet risk reduction thresholds, Clean Water Act authorities for TMDLs, discharge permits and enforcement actions must be considered. How will CWA efforts be implemented to assure that upstream waters meet water quality standards? It would be beneficial for EPA to include an explanation of the collaboration efforts that will be conducted by the Water, Superfund, and Enforcement programs to affect a successful cleanup.

As discussed in the Oregon Department of Environmental Quality (DEQ) Source Control Report:

> "Section 303(d) impairment pollutants in the lowest reach of Willamette River include: aldrin, biological criteria, chlordane, cyanide, DDT, DDE, dieldrin, hexachlorobenzene, iron, manganese, PCBs, pentachlorophenol, PAHs and chlorophyll *a*. EPA-approved TMDL parameters in the lowest reach include Dioxin (2,3,7,8 TCDD), e coli, mercury and temperature. In alignment with the current Performance Partnership Agreement between DEQ and EPA Region 10, DEQ is not currently pursuing TMDLs for the remaining impairment parameters. Due to completion of removal and capping in the river at the McCormick and Baxter site, and following eight years of post-remedy water quality monitoring there, DEQ is proposing to delist pentachlorophenol. DEQ anticipates that Portland Harbor post-remedy water quality monitoring will also allow delisting of several additional toxics parameters, such that development of TMDLs for those parameters will not be necessary."

EPA should develop a plan to return the Willamette River to a status of health, particularly for the contaminants such as DDT, DDE, PCBs, and PAHs that are causing 303(d) impairment of the waters and for which currently there is no TMDL underway nor a process to delist.

Protection of Human Health and the Environment, a threshold criteria, remains elusive.

Based on the approach defined in the FS for assessing the protection of human health, none of the proposed alternatives would be considered protective. EPA has established RAOs for protection of human health for the cleanup, which are provided in the FS Section 2:

- RAO 1 – Sediments: Reduce cancer and non-cancer risks to people from incidental ingestion of and dermal contact with COCs in sediments and beaches to exposure levels that are acceptable for fishing, occupational, recreational, and ceremonial uses.

- RAO 2 – Biota: Reduce cancer and non-cancer risks to acceptable exposure levels (direct and indirect) for human consumption of COCs in fish and shellfish.

- RAO 3 – Surface Water: Reduce cancer and non-cancer risks to people from direct contact (ingestion, inhalation, and dermal contact) with COCs in surface water to exposure levels that are acceptable for fishing, occupational, recreational, and potential drinking water supply.

- RAO 4 – Groundwater: Reduce migration of COCs in groundwater to sediment and surface water such that levels are acceptable in sediment and surface water for human exposure.

The EPA also established RAOs, listed below, to address ecological risks posed by the contaminated sediments within the Site boundaries.

- RAO 5 – Sediments: Reduce risk to ecological receptors from the ingestion of direct contact with COCs in sediments to acceptable exposure levels.

- RAO 6 – Biota (Predators): Reduce risks to ecological receptors that consume COCs in prey to acceptable exposure levels.

An estimated 2,450 acres of the Site are contaminated with sediments that exceed the human health PRGs. EPA set progressively more stringent RALs for Alternatives B through G. For Alternatives E, F, and G, **Table 1** shows the RALs and corresponding areas exceeding the RALs for PCBs, PAHs, and DDx. The RAL for PCBs in sediment associated with Alternative G is 50 ppb. Alternative G calls for dredging 564 acres of the Study Area resulting in an 82 percent reduction in risks from PCBs.

According to the FS Section 4.1.4, "The protection of human health is assessed by comparing the PRGs for RAOs 1 (sediment only) and 2 to estimated contaminant concentrations in sediment at the completion of construction." Furthermore, according to **Table 4.3-1** (attached), for all alternatives, RAO 2 is "Not within acceptable risk range post-construction." Because protection of human health is based on assessing RAOs 1 and 2 at the completion of construction, and because no alternative is within the acceptable risk range for RAO 2 at the completion of construction, none of the alternatives are considered protective of human health.

The FS acknowledges, however, that "there are no current means to quantitatively assess the effectiveness of the remedial activities on overall concentrations in beaches, surface water, and pore water," and that the "[t]ime to achieve protectiveness" is "uncertain."

Table 4 (attached) is a comparison of protectiveness for Alternatives E, F, and G and No Action, which represents the baseline risks at the Site. While risk reduction occurs soonest under Alternative G, post-construction human health risks from fish consumption (cancer risk of less than 1 in 1000) and non-cancer risks to children and infants are unacceptable, in part, as a result of PCBs. Post-construction benthic ecosystem risks are also unacceptable based on hazard quotients greater than one.

Unfortunately, the use of modeling to evaluate the effectiveness of the alternatives in reducing risk over the long-term was determined to be infeasible given the complexities of the Site and the schedule for the project. EPA's cleanup should assure that the remedial action objectives will be met.

Compliance with ARARs, a threshold criteria, following cleanup, is not possible.

The cleanup alternatives considered in the FS do not comply with Oregon water quality criteria or the Oregon Hazardous Substance Remedial Action Rules. The FS section 2.1.1, on chemical-specific ARARs, states: "In addition to numeric water quality criteria, Oregon narrative water quality criteria are potential ARARs that EPA will translate into numeric standards for each COC through the final remediation goals." Relevant narrative criteria in the Oregon water quality standards include the following:

> *Toxic substances may not be introduced above natural background levels in waters of the state in amounts, concentrations, or combinations that may be harmful, may chemically change to harmful forms in the environment, or may accumulate in sediments or bioaccumulate in aquatic life or wildlife to levels that adversely affect public health, safety, or welfare or aquatic life, wildlife, or other designated beneficial uses. (OAR 340-041-0033)*
>
> *The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry may not be allowed. (OAR 340-041-0007(11))*

Because all proposed alternatives are deemed “not within acceptable risk range post-construction” for RAO 2 (fish and shellfish consumption), they should be considered to “adversely affect public health, safety, or welfare,” and would therefore not be in compliance with state narrative water quality standards (an ARAR).

The FS section 2.1.1 also states that the measure of protectiveness of human health and the environment included in the *Oregon Hazardous Substance Remedial Action Rules, OAR 340-122* “are considered applicable to the Portland Harbor site.” These include:

- A 1 in 1,000,000 (1×10^{-6}) lifetime excess cancer risk for individual carcinogens
- A 1 in 100,000 (1×10^{-5}) cumulative lifetime excess cancer risk for multiple carcinogens
- A HI of 1 for non-carcinogens

However, “acceptable risk ranges” considered in the FS appear to be based not on these values, but on a broader and less protective risk range used by EPA. For example, in Section 4.2.2.3, it is stated that “Estimated post-construction cancer risks…are generally less than 5×10^{-5}, which is within EPA’s acceptable risk range.” However, this exceeds the acceptable risk range of 1×10^{-5}, which was determined to be an ARAR.

Natural attenuation has not solved the problem; the sediments will not remediate naturally.

Historically, waste and wastewater from industrial processes and private and municipal sewage was disposed of by dumping it into the Willamette River. This practice has not continued for several decades, yet contaminated sediments remain.

As described in DEQ’s Source Control Summary Report, DEQ began working to clean up sources to this area of the Willamette River in the late 1980s. In 1997, EPA initiated a sediment investigation in a six mile reach considered likely to have the highest chemical concentrations based on the presence of a number of long-standing industrial sources. The study indicated that contaminant migration and resuspension were limited and pointed to areas of high chemical concentrations in river sediments that were not near known upland pollution sources (ODEQ, 2014).

Given elevated concentrations of contaminants in sediments upstream of the site, and limited resuspension of sediments in the study area, natural recovery of the contaminated sediments in a reasonable time frame seems unlikely.

For the cleanup alternatives evaluated, high levels of PCBs will be left in areas of the river and the watershed where sediments and fish will remain contaminated.

Even after the implementation and completion of cleanup, using the most stringent alternatives proposed, the cleanup effort would result in concentrations of PCBs and other persistent organic pollutants that pose unacceptable risk for human uses of the river, particularly those populations engaged in harvesting and consuming fish and shellfish from the Site. The attached **Table 5** shows a number of contaminant groups that will fail to meet the requisite PRGs after remediation for the FS Alternatives E, F, and G. Even the most stringent proposed alternative leave carcinogenic PAHs (cPAHs), DDx, dieldrin, hexachlorobenzene, PCBs, HxCDF, TDDF, BEHP, PeCDF, and TCDF at concentrations great than PRGs.

Figure 3.3-13 (attached) presented in the Draft Final FS indicates the areas, by sediment decision unit (SDU) that will be addressed during each proposed alternative.

Fish consumption advisories as a solution is unacceptable to the Yakama Nation.

In 2000, the EPA published guidance and recommendations on the use of fish and shellfish consumption advisories in determining attainment of water quality standards and listing impaired waterbodies under Section 303(d) of the CWA (EPA, 2000), which includes the following statement:

> EPA generally believes that fish and shellfish consumption advisories and certain shellfish growing area classifications based on waterbody specific information demonstrate impairment of CWA section 101(a) "fishable" uses. This applies to fish and shellfish consumption advisories and certain shellfish area classifications for all pollutants that constitute potential risks to human health, regardless of the source of the pollutant.

Section 4.1.4 of the FS states that:

> *To determine whether the tissue PRGs for RAO 2 are expected to be achieved, predicted concentrations in sediment at MNR Year 0 are used to estimate concentrations in fish and shellfish tissue. Where the estimated tissue concentrations exceed PRGs for RAO 2, then it will be assumed that a fish consumption advisory will be necessary to provide protection in the short- and/or long-term.*

Based on **Table 4.3-1** (attached), none of the proposed alternatives would be within the acceptable risk range post-construction for RAO 2. This would imply that a fish consumption advisory will be necessary following the implementation of any of the alternatives. Based on EPA guidance, this advisory would demonstrate impairment of the fishable use of waters in the project area, and would therefore not be considered in compliance with ARARs based on state water quality standards.

The long-term effectiveness and permanence of remedies that leave contaminants in the river should consider impacts of geologic hazards and climate change.

The FS should have evaluated how known geologic hazards, specifically seismic shaking intensity, amplification, and liquefaction, may impact the reliability, long-term effectiveness, and permanence of the remedial alternatives. For alternatives that involve MNR, EMNR, or capping, geologic hazards may affect the long-term efficacy of the remedy.

A helpful resource is a map at https://www.portlandoregon.gov/pbem/article/394641 created by the Portland Bureau of Emergency Management (PBEM) that compiles information from a variety of existing sources; including data from the U.S. Geological Survey (USGS), Federal Emergency Management Agency (FEMA) and Oregon Department of Geology and Mineral Industries (DOGAMI).

Also, Hazvu is a web viewer created by Oregon Department of Geology and Mineral Industries (DOGAMI) by compiling information from a variety of existing sources; including data from the U.S. Geological Survey (USGS), Oregon Department of Land Conservation and Development (DLCD), Pacific Northwest Seismic Network (PNSN), and Federal Emergency Management Agency (FEMA). http://www.oregongeology.org/hazvu/

Also, the FS could consider how a changing climate may impact the reliability, long-term effectiveness, and permanence of the remedial alternatives. Key potential climate change impacts that may be expected for the Portland Harbor include increased heavy precipitation events, sea level rise, and increased flood risk. Please refer to the Climate Change Adaptation Technical Fact Sheet: Contaminated Sediment Remedies (EPA, 2015).

Monitoring at the Site and upstream and downstream of the Site should occur through the design phase, during construction, and following remediation in order to properly gage success and reduction in pollutant loads.

Unfortunately, the use of modeling to evaluate the effectiveness of the alternatives in reducing risk over the long term was determined to be infeasible given the complexities of the site and the schedule for the project. How will EPA assure that the remedial action objectives will be met? Long-term monitoring of the of surface water, pore water, and sediments at the Site, as well as areas upstream and downstream will be key to gaging the effectiveness of the cleanup in meeting remedial goals.

It is recommended that EPA provide more detail on the elements and expectations of a monitoring program in the cleanup plan. Metrics should be established to gage progress. The program should be clear about when decisions regarding amending or modification of the ROD will be made should remediation not achieve the expected outcome. For example, what conditions (e.g., the rate of decrease in contamination) must be met and what are the consequences of failing to meet those conditions?

As noted above, the Yakama Nation is concerned that full protectiveness may not be achieved through active remediation. It is imperative that EPA establish clear guidelines and time-frames to judge whether the actions that are taken result in reasonable rates of risk reduction after construction.

Natural resource injuries to the Lower Columbia River as a result of hazardous substance releases from the Portland Harbor Superfund Site may be significant.

The contamination from the Portland Harbor Superfund Site does not stop at the Willamette River. Harmful and toxic pollutants from the Willamette River are carried into the Columbia River and have been found in salmon below the confluence of these two rivers.

The Lower Columbia River has a number of Pacific salmon and steelhead species and other economically and culturally important fish of which several are evolutionarily significant and listed as threatened and endangered under the U.S. endangered Species Act. While a number of factors (habitat loss, overharvesting, presence of dams, and climate change) have been implicated in declining abundance in the Columbia River, chemical contaminants represent yet another threat to aquatic and aquatic-dependent species and the human populations that use these resources.

A number of studies have documented impacts caused by persistent organic pollutants (like PCBs, DDT, PAHs, and dioxins/furans) in the Lower Columbia River. High concentrations of PCBs, PAHs, and DDT have been measured in sediments, water, and biota within the Portland Harbor Superfund Site in the Lower Willamette River. The downstream impact of agricultural practices, dense urbanization, and historical and present day industry along the lower Willamette River (specifically within Portland Harbor) and the Willamette River watershed are of concern.

Anadromous juvenile Chinook salmon that hatch and spend their first year in freshwater, are observed during estuary residence to accumulate persistent organics in tissues and bile and from food sources (measured in stomach contents) in contaminated estuaries from the Columbia and Duwamish Rivers. PCBs, PAHs, and DDT are present in the stomach contents, at concentrations that significantly correlate with contaminant body burdens in fish from the same sites (Johnson et al., 2007).

The distribution of PAHs in Chinook salmon stomach contents and bile (representing recent PAHs exposure in fish since it does not bioaccumulate in tissue) were measured from the Columbia River from the estuary to the Bonneville Dam and the Lower Willamette River (Yanagida et al. 2012).

Concentrations of PAHs were highest in fish collected in the Lower Willamette River and then at the Willamette-Columbia Confluence. PAH concentrations measured in dietary (stomach content) samples were near the threshold concentration associated with variability and immune dysfunction in juvenile salmonids. PAH metabolites measured in fish bile were found at concentrations in the Willamette River and Willamette-Columbia confluence linked to growth impairment, altered energetics, and adverse reproductive effects. Concentrations of PAHs in the food chain found in these areas along the Lower Willamette River and the Willamette-Columbia Confluence indicate a potential source of injury to juvenile salmon downgradient of these contaminant sources.

Complimentary studies (Johnson et al., 2014) indicate that PCBs and DDT were frequently detected in juvenile salmon and stomach content samples from the lower Columba River and estuary. In some cases (32 percent of samples for PCBs), concentrations in salmon were above estimated threshold values for adverse health effects for growth and survival. The tidal freshwater portion of the estuary, between Portland, Oregon and Longview, Washington appeared to be an important source of contaminants for juvenile salmon and a region in which salmon were exposed to toxic pollutants associated with urban development and industrial activity. The highest concentrations of PCBs were found in fall juvenile Chinook stocks with subyearling life histories (including populations from the upper Columbia and Snake Rivers) which feed and rear in the tidal freshwater and estuarine portions of the river for extended periods. Similar populations of spring juvenile Chinook with yearling life histories that migrate more rapidly through the estuary generally had lower PCB levels, but high concentrations of DDT, likely a result of the increased prevalence in their spawning and rearing habitat. The importance of the Portland-Vancouver Columbia River stretch is emphasized as a source of PCB contamination because stocks of fish in the Columbia Gorge area above the Willamette-Columbia Confluence were lower in concentration that their downstream peers. No Chinook salmon sampled above the confluence had PCB concentrations exceeding the 2,400 ng/g lipid threshold, while 36 percent collected at or below the confluence had PCB concentrations that exceeded this concentration.

The impact of contaminant stressors, especially coupled with other environmental conditions, may adversely affect the health of juvenile Chinook and other important species found in the Lower Columbia River. Exposure to these contaminants may result in injury and potentially impede the recovery of these and other important fish species.

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Table 1. Final Remedial Action Limits for Focused COCs

Focused COC	RAL (µg/kg)					
	Alt B	**Alt C**	**Alt D**	**Alt E**	**Alt F**	**Alt G**
PCBs	1,000	750	500	200	75	50
Total PAHs	170,000	130,000	69,000	35,000	13,000	5,400
2,3,7,8-TCDD	0.002	0.002	0.002	0.0006	0.0006	0.0006
1,2,3,7,8-PeCDD	0.003	0.002	0.0008	0.0008	0.0008	0.0008
2,3,4,7,8-PeCDF	1	1	1	0.2	0.2	0.009
DDx	650	550	450	300	160	40

Source: Table 3.3-5, Draft Final Feasability Study, Portland Harbor RI/FS (July 2015)

Table 2. Summary of Risk Reduction for Feasability Study Alternatives E, F, and G

Remedial Impact	Alternative			Source of Information
	E	F	G	
PCBs				
PCB Remedial Action Level (RAL, ppb)	200	75	50	Table 3.3-1
Acres exceeding the PCB RAL	124	343	515	Table 3.3-1
% Reduction in Risk from PCBs	**63**	**75**	**82**	Table 3.7-1
PAHs				
PAH Remedial Action Level (RAL, ppm)	35	13	5.4	Table 3.3-2
Acres exceeding the PAH RAL	99	157	286	Table 3.3-2
% Reduction in Risk from PAHs	**90**	**93**	**96**	Table 3.7-1
DDx				
DDx Remedial Action Level (RAL, ppb)	300	160	40	Table 3.3-4
Acres exceeding the DDx RAL	22	33	110	Table 3.3-4
% Reduction in Risk from PAHs	**73**	**79**	**85**	Table 3.7-1
Remedial Activity				
Dredging	219	386	564	Table 3.6-2
Capping	34	90	163	Table 3.6-2
Dredge/Cap	17	38	53	Table 3.6-2
In-Situ Treatment	0	0	0	Table 3.6-2
EMNR	59	24	15	Table 3.6-2
Total Remediation Area (acres)	**329**	**538**	**795**	Table 3.6-2

Source: Section 3, Draft Final Feasability Study, Portland Harbor RI/FS (July 2015)

Table 3. Treatment Areas, Volumes, Construction Times, and Cost Ranges for the FS Alternatives

Alternative	Treatment Area (Tables 3.6-2 and 3.7-2)						Table 3.7-2	Section 4	Appendix G
	Dredge Area (acres)	Cap Area (acres)	Dredge/Cap Area (acres)	In-Situ Treatment (acres)	EMNR (acres)	Total (acres)	Dredge Volume (CY)	Construction Time (Years)	Cost Range (Billions of $)
A	0	0	0	0	0	0	0	0	0
B	76	9	5	7	103	200	614,130 to 818,830	4	$0.55 - $1.19
C	93	13	7	5	101	219	762,000 to 1,016,000	NA	NA
D	140	22	11	3	88	264	1,172,920 to 1,563,900	5	$0.77 - $1.66
E	219	34	17	0	59	329	2,061,390 to 2,748,520	7	$1.04 - $2.24
F	386	90	38	0	24	538	4,282,540 to 5,843,380	12	$1.44 - $3.08
G	564	163	53	0	15	795	6,865,250 to 9,153,660	18	$1.71 - $3.67

Notes:
1. Alternative C is not included in the detailed analysis of remedial alternatives.
2. NA = Not Analyzed

Source: Section 3, Draft Final Feasability Study, Portland Harbor RI/FS (July and August 2015)

Table 4. Summary of Protectiveness for FS Alternatives E, F, and G

Remedial Action Objectives	Baseline Risks (No Action Alternative)	Alternative E	Alternative F	Alternative G	Comments
Protection of Human Health					
RAO 1 - Sediments	Not Protective	Acceptable	Acceptable	Acceptable	
RAO 2 - Biota	Not Protective	Unacceptable	Unacceptable	Unacceptable	
RAO 3 - Surface Water	Not Protective	Better than D	Better than D	Better than D	
RAO 4 - Groundwater	Not Protective	Better than D	Better than D	Better than D	
Protection of Environment					
RAO 5 - Sediments	Not Protective	Unacceptable	Unacceptable	Unacceptable	
RAO 6 - Biota (Predators)	Not Protective	Not Protective	Not Protective	Not Protective	
RAO 7 - Surface Water	Not Protective	Soon	Sooner	Soonest	
RAO 8 - Groundwater	Not Protective	Soon	Sooner	Soonest	
Residual Risks Post Construction					
RAO 1 - Direct Contact Cancer Risk	< 4x10-4 (< 1 in 40,000)	< 1 in 100,000	< 1 in 100,000	< 1 in 100,000	E-risks greater than background risk in several areas
RAO 2 - Fish Consumption Cancer Risk	< 4x10-2 (< 1 in 400)	< 2x10-3	< 1x10-3	< 1x10-3	Consumption of contaminated fish and shellfish
RAO 2 - Child Non-Cancer Hazard	590	40	30	30	PCBs and HxCDF pose continued risk; show adverse health effects
RAO 2 - Infant Non-Cancer Hazard	210,000	8,000	7,000	6,000	PCBs and dioxin/furan posed continued risk; based on consumption of breast milk
RAO 5 - Ecological Hazard Quotient	< 100	<30	<25	<10	Benthic risks continue
RAO 6 - Residual Risk to Ecosystem	< 150	<5	<5	<5	Overall risk continues

Source: Table 4.3-1, Draft Final Feasability Report, Portland Harbor RI/FS (August 2015)

Table 5. Sediment Decision Units Failing to meet PRGs for FS Alternatives E, F, and G

RAO	Alternative E	Alternative F	Alternative G
RAO 1 - Sediments	**As** in 2E, 5.5E, 3.9W	**As** in 3.9W	
	cPAHs in 2E, 4.5E,5.5E,6.5E,3.9W,5W, 6NAV, 6W,7W	**cPAHs** in 2E, 4.5E,5.5E,6.5E,3.9W,5W, 6NAV, 6W	**cPAHs** in 4.5E,5.5E,6.5E,3.9W,5W, 6NAV, 6W
RAO 2 - Biota	**Aldrin** in 4.5E		
	Chlordanes in 2E, 4.5E,5.5E,11E,7W,9W	**Chlordanes** in 4.5E,11E	
	DDx in 2E,4.5E,5.5E,11E,3.9W,5W,6W,7W,9W	**DDx** in 3.9W,5W,6W,7W	**DDx** in 3.9W,7W
	Dieldrin 2E,4.5E,5.5E,11E,5W,6NAV,6W,7W,9W	**Dieldrin** in 2E,4.5E5.5E,7W	**Dieldrin** in 2E,4.5E,7W
	Hexachlorobenzene in 2E,3.5E, 4.5E,5.5E,6.5E,SIL,11E,3.9W,5W, 6NAV, 6W,7W,9W	**Hexachlorobenzene** in 2E,3.5E, 4.5E,5.5E,6.5E,SIL,11E,3.9W,5W, 6NAV, 6W,7W,9W	**Hexachlorobenzene** in 2E,3.5E, 4.5E,5.5E,6.5E,SIL,11E,3.9W,5W, 6NAV, 6W,7W,9W
	PCBs in 2E,3.5E, 4.5E,5.5E,6.5E,SIL,11E,3.9W,5W, 6NAV, 6W,7W,9W	**PCBs** in 2E,3.5E, 4.5E,5.5E,6.5E,SIL,11E,3.9W,5W,7W,9W	**PCBs** in 2E,3.5E, 4.5E,5.5E,6.5E,SIL,11E,3.9W,5W,9W
	HxCDF in 4.5E,5.5E,SIL,5W,6W,7W	**HxCDF** in 5.5E,SIL,5W,7W	**HxCDF** in 5.5E,SIL,7W
	PeCDD in 5.5E,6.5E,11E	**PeCDD** in 5.5E,6.5E,11E	
	PeCDF in 4.5E,5.5E,6.5E,3.9W,5W,6NAV,6W,7W,9W	**PeCDF** in 4.5E,5.5E,6.5E,3.9W,5W,6NAV,6W,7W	**PeCDF** in 5.5E,6.5E,5W,6NAV,7W
	TCDF in 5.5E,3.9W,5W,6NAV,6W,7W	**TCDF** in 5.5E,3.9W,5W,6NAV,7W	**TCDF** in 5.5E,5W,7W
RAO 5 - Sediments	**BEHP** in 3.5,4.5,5.5,3.9W,7W,9W	**BEHP** in 3.5E,3.9W,7W	**BEHP** in 3.9W
RAO 6 - Biota (Predators)	**DDE** in 3.9W,7W,9W	**DDE** in 3.9W,7W	
	PCBs in 2E,3.5E,4.5E.5.5E,11E,9W		
	HxCDF in 7W	**HxCDF** in 7W	
	PeCDF in 7W	**PeCDF** in 7W	**PeCDF** in 7W
	TCDF in 7W	**TCDF** in 7W	**TCDF** in 7W

Source: Tables 4.2-20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31
from Section 4, Draft Final Feasability Study, Portland Harbor RI/FS (Augutst 2015)

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Criteria	Alternative A	Alternative B	Alternative D	Alternative E	Alternative F	Alternative G
Overall Protection of Human Health and the Environment						
Human Health	Not protective, does not meet RAOs 1 through 4	RAO 1 – Not within acceptable risk range post-construction, would rely on MNR and ICs. Time to achieve protectiveness through MNR uncertain RAO 2 – Not within acceptable risk range post-construction, would rely on MNR and ICs. Time to achieve protectiveness through MNR uncertain RAO 3 – Time to achieve protectiveness through MNR uncertain RAO 4 – Time to achieve protectiveness through MNR uncertain	RAO 1 – Within acceptable risk range post-construction RAO 2 – Not within acceptable risk range post-construction, would rely on MNR and ICs. Time to achieve protectiveness through MNR less than B RAO 3 – Time to achieve protectiveness through MNR less than B RAO 4 – Time to achieve protectiveness through MNR less than B	RAO 1 – Within acceptable risk range post-construction RAO 2 – Not within acceptable risk range post-construction, would rely on MNR and ICs. Time to achieve protectiveness through MNR less than D RAO 3 – Time to achieve protectiveness through MNR less than D RAO 4 – Time to achieve protectiveness through MNR less than D	RAO 1 – Within acceptable risk range post-construction RAO 2 – Not within acceptable risk range post-construction, would rely on MNR and ICs. Time to achieve protectiveness through MNR less than D RAO 3 – Time to achieve protectiveness through MNR less than D RAO 4 – Time to achieve protectiveness through MNR less than D	RAO 1 – Within acceptable risk range post-construction RAO 2 – Not within acceptable risk range post-construction, would rely on MNR and ICs. Time to achieve protectiveness through MNR less than D RAO 3 – Time to achieve protectiveness through MNR less than D RAO 4 – Time to achieve protectiveness through MNR less than D
Environment	Not protective, does not meet RAOs 5 through 8	RAO 5 – Unacceptable ecological risks remain post-construction. Time to achieve protectiveness through MNR uncertain RAO 6 – Unacceptable ecological risks remain post-construction. Time to achieve protectiveness through MNR uncertain RAO 7 – Time to achieve protectiveness through MNR uncertain RAO 8 – Time to achieve protectiveness through MNR uncertain	RAO 5 – Unacceptable ecological risks remain post-construction. Time to achieve protectiveness through MNR less than B RAO 6 – Unacceptable ecological risks remain post-construction. Time to achieve protectiveness through MNR less than B RAO 7 – Time to achieve protectiveness through MNR less than B RAO 8 – Time to achieve protectiveness through MNR less than B	RAO 5 – Unacceptable ecological risks remain post-construction. Time to achieve protectiveness through MNR less than D RAO 6 – Unacceptable ecological risks remain post-construction. Time to achieve protectiveness through MNR less than D RAO 7 – Time to achieve protectiveness through MNR less than D RAO 8 – Time to achieve protectiveness through MNR less than D	RAO 5 – Unacceptable ecological risks remain post-construction. Time to achieve protectiveness through MNR less than E RAO 6 – Unacceptable ecological risks remain post-construction. Time to achieve protectiveness through MNR less than E RAO 7 – Time to achieve protectiveness through MNR less than E RAO 8 – Time to achieve protectiveness through MNR less than E	RAO 5 – Unacceptable ecological risks remain post-construction. Time to achieve protectiveness through MNR less than F RAO 6 – Unacceptable ecological risks remain post-construction. Time to achieve protectiveness through MNR less than F RAO 7 – Time to achieve protectiveness through MNR less than F RAO 8 – Time to achieve protectiveness through MNR less than F

Criteria	Alternative A	Alternative B	Alternative D	Alternative E	Alternative F	Alternative G
Compliance with ARARs						
Chemical-specific ARARs	Does not comply	Would be met over time through a combination of in-river remedial technologies and institutional controls	Would be met over time through a combination of in-river remedial technologies and institutional controls	Would be met over time through a combination of in-river remedial technologies and institutional controls	Would be met over time through a combination of in-river remedial technologies and institutional controls	Would be met over time through a combination of in-river remedial technologies and institutional controls
Location-specific ARARs	Do not apply	Complies. Would be addressed during design and implementation	Complies. Would be addressed during design and implementation	Complies. Would be addressed during design and implementation	Complies. Would be addressed during design and implementation	Complies. Would be addressed during design and implementation
Action-specific ARARs	Do not apply	Complies. Would be addressed during design and implementation	Complies. Would be addressed during design and implementation	Complies. Would be addressed during design and implementation	Complies. Would be addressed during design and implementation	Complies. Would be addressed during design and implementation

Criteria	Alternative A	Alternative B	Alternative D	Alternative E	Alternative F	Alternative G
Long-term Effectiveness and Permanence						
Magnitude of Residual Risks	RAO 1 – No reduction in cancer risk of 4 x 10^{-4} RAO 2 – No reduction in cancer risk of 4 x 10^{-2}, child hazard of 600, and infant hazard of 210,000 RAO 3 – Not quantifiable. Time to achieve protectiveness through MNR uncertain RAO 4 – Note quantifiable. Time to achieve protectiveness through MNR uncertain RAO 5 – Does not reduce ecological HQ of 80 RAO 6 – Does not reduce ecological HQ of 100 RAO 7 – Not quantifiable. Time to achieve protectiveness through MNR uncertain RAO 8 – Not quantifiable. Time to achieve protectiveness through MNR uncertain	RAO 1 – Post-construction cancer risk reduced to less than 3 x 10^{-5} RAO 2 – Post-construction cancer risk reduced to 3 x 10^{-3}, child hazard to 70, and infant hazard to 15,000 RAO 3 – Not quantifiable. Time to achieve protectiveness through MNR uncertain RAO 4 – Note quantifiable. Time to achieve protectiveness through MNR uncertain RAO 5 – Reduces post-construction ecological HQ to less than 30 RAO 6 – Reduces post-construction ecological HQ to less than 10 RAO 7 – Not quantifiable. Time to achieve protectiveness through MNR uncertain RAO 8 – Not quantifiable. Time to achieve protectiveness through MNR uncertain	RAO 1 – Post-construction cancer risk reduced to less than 2 x 10^{-5} RAO 2 – Post-construction cancer risk reduced to 3 x 10^{-3}, child hazard to 50, and infant hazard to 12,000 RAO 3 – Not quantifiable. Time to achieve protectiveness through MNR uncertain RAO 4 – Note quantifiable. Time to achieve protectiveness through MNR uncertain RAO 5 – Reduces post-construction ecological HQ to less than 30 RAO 6 – Reduces post-construction ecological HQ to less than 10 RAO 7 – Not quantifiable. Time to achieve protectiveness through MNR uncertain RAO 8 – Not quantifiable. Time to achieve protectiveness through MNR uncertain	RAO 1 – Post-construction cancer risk reduced to less than 1 x 10^{-5} RAO 2 – Post-construction cancer risk reduced to 3 x 10^{-3}, child hazard to 40, and infant hazard to 8,000 RAO 3 – Not quantifiable. Time to achieve protectiveness through MNR uncertain RAO 4 – Note quantifiable. Time to achieve protectiveness through MNR uncertain RAO 5 – Reduces post-construction ecological HQ to less than 30 RAO 6 – Reduces post-construction ecological HQ to less than 5 RAO 7 – Not quantifiable. Time to achieve protectiveness through MNR uncertain RAO 8 – Not quantifiable. Time to achieve protectiveness through MNR uncertain	RAO 1 – Post-construction cancer risk reduced to less than 1 x 10^{-5} RAO 2 – Post-construction cancer risk reduced to 3 x 10^{-3}, child hazard to 30, and infant hazard to 7,000 RAO 3 – Not quantifiable. Time to achieve protectiveness through MNR uncertain RAO 4 – Note quantifiable. Time to achieve protectiveness through MNR uncertain RAO 5 – Reduces post-construction ecological HQ to less than 25 RAO 6 – Reduces post-construction ecological HQ to less than 5 RAO 7 – Not quantifiable. Time to achieve protectiveness through MNR uncertain RAO 8 – Not quantifiable. Time to achieve protectiveness through MNR uncertain	RAO 1 – Post-construction cancer risk reduced to less than 1 x 10^{-5} RAO 2 – Post-construction cancer risk reduced to 3 x 10^{-3}, child hazard to 30, and infant hazard to 6,000 RAO 3 – Not quantifiable. Time to achieve protectiveness through MNR uncertain RAO 4 – Note quantifiable. Time to achieve protectiveness through MNR uncertain RAO 5 – Reduces post-construction ecological HQ to less than 10 RAO 6 – Reduces post-construction ecological HQ to less than 5 RAO 7 – Not quantifiable. Time to achieve protectiveness through MNR uncertain RAO 8 – Not quantifiable. Time to achieve protectiveness through MNR uncertain

Criteria	Alternative A	Alternative B	Alternative D	Alternative E	Alternative F	Alternative G
Adequacy and Reliability of Controls	No engineering controls, existing fish advisories are unlikely to be protective and do not reduce risk to ecological receptors	Removal, capping, and thermal treatment are proven and reliable technologies. Long-term monitoring and eventual partial or complete replacement of materials left in place (caps/EMNR amendments) to ensure continued effectiveness long-term. ICs include fish consumption advisories and RNAs to protect caps. Effectiveness monitoring of controls includes periodic sampling of environmental and biotic media. Periodic inspections of buoys of other devices used to delineate RNAs.	Same as B, except additional O&M, ICs and monitoring would be required due to the increase in the acreage of caps.	Same as D, except additional O&M, ICs and monitoring would be required due to the increase in the acreage of caps.	Same as E, except additional O&M, ICs and monitoring would be required due to the increase in the acreage of caps.	Same as F, except additional O&M, ICs and monitoring would be required due to the increase in the acreage of caps.
Reduction of Toxicity, Mobility or Volume through Treatment						
Treatment Process Used	No treatment processes utilized	Activated carbon, organophilic clay, Solidification/ stabilization	Same as Alternative B	Same as Alternative B	Same as Alternative B	Same as Alternative B
Amount Destroyed or Treated	No amount of contaminants will be destroyed or treated	83 acres treated in-situ 330,000 cy treated ex-situ	123 acres treated in-situ 395,000 cy treated ex-situ	197 acres treated in-situ 442,000 cy treated ex-situ	203 acres treated in-situ 506,000 cy treated ex-situ	238 acres treated in-situ 528,000 cy treated ex-situ
Reduction in Toxicity, Mobility, or Volume	No reduction through treatment	7 acres broadcast activated carbon 19 acres reactive caps 55 acres reactive residual layer 2 acres significantly augmented reactive cap	3 acres broadcast activated carbon 27 acres reactive caps 92 acres reactive residual layer 3 acres significantly augmented reactive cap	0 acres broadcast activated carbon 39 acres reactive caps 155 acres reactive residual layer 13 acres significantly augmented reactive cap	0 acres broadcast activated carbon 67 acres reactive caps 166 acres reactive residual layer 4 acres significantly augmented reactive cap	0 acres broadcast activated carbon 83 acres reactive caps 187 acres reactive residual layer 4z acres significantly augmented reactive cap

Criteria	Alternative A	Alternative B	Alternative D	Alternative E	Alternative F	Alternative G
Irreversible Treatment	No irreversible treatments utilized	Activated carbon in-situ treatment considered permanent and irreversible Low-temperature thermal desorption, with secondary treatment such as catalytic oxidation or carbon absorption) is considered permanent and irreversible Solidification/ stabilization form stable solids that are non-hazardous or less-hazardous than the original materials	Same as Alternative B	Same as Alternative B	Same as Alternative B	Same as Alternative B
Type and Quantity of Residuals Remaining after Treatment		Would not address 69% of PTW	Would not address 46% of PTW	Would not address 3% of PTW	Would not address 1% of PTW	Would not address 1% of PTW
Implementability						
Ability to Construct and Operate	Construction or operation is not conducted.	Easy to construct. Would require 314,000 cy material handling and 872,000 cy dredge material.	More extensive than Alternative B. Would require 574,000 cy material handling and 1,637,000 cy dredge material.	More extensive than Alternative D. Would require 866,000 cy material handling and 2,838,000 cy dredge material.	More extensive than Alternative E. Would require 1,608,000 cy material handling and 5,951,000 cy dredge material.	More extensive than Alternative F. Would require 2,434,000 cy material handling and 9,278,000 cy dredge material.
Ease of Doing More Action, if Needed	May require ROD amendment in the future	Easy to extend extent of construction activities	Easy to extend extent of construction activities	Easy to extend extent of construction activities	Easy to extend extent of construction activities	Easy to extend extent of construction activities

Criteria	Alternative A	Alternative B	Alternative D	Alternative E	Alternative F	Alternative G
Ability to Monitor Effectiveness	Monitoring not required. Ongoing potential for consuming contaminated fish and shellfish as well as exposures to other media.	Monitoring and maintenance inspections will give notice of failure before significant exposure occurs.	Monitoring and maintenance inspections will give notice of failure before significant exposure occurs.	Monitoring and maintenance inspections will give notice of failure before significant exposure occurs.	Monitoring and maintenance inspections will give notice of failure before significant exposure occurs.	Monitoring and maintenance inspections will give notice of failure before significant exposure occurs.
Ability to Obtain Approvals and Coordinate with Other Agencies	No approvals necessary.	Approvals required.	Approvals required.	Approvals required.	Approvals required.	Approvals required.
Availability of Specialists, Equipment and Materials	Services, equipment, and materials are not required.	Dredge operators required. Material placement experts required. Equipment and materials readily accessible.	Specialists and equipment are needed for longer duration than Alternative B. More material is needed than Alternative B.	Specialists and equipment are needed for longer duration than Alternative D. More material is needed than Alternative D.	Specialists and equipment are needed for longer duration than Alternative E. More material is needed than Alternative E.	Specialists and equipment are needed for longer duration than Alternative F. More material is needed than Alternative F.
Availability of Technologies	Technologies to address contaminated media are not required.	All technologies readily available.	All technologies readily available.	All technologies readily available.	All technologies readily available.	All technologies readily available.
Short Term Effectiveness						

Criteria	Alternative A	Alternative B	Alternative D	Alternative E	Alternative F	Alternative G
Community Protection	No impacts to the community due to construction Continued risks from uncontrolled exposures. OHA fish advisories would continue	Impacts to community for ~2 years Temporary noise, light, odors, air quality impacts. Disruptions to commercial and recreational river use, potential for waterborne accidents during construction Increased vehicular traffic, increased accident risk and air-quality issues Least amount of dredged and borrow materials requiring handling and transport. Exposure to contamination greater than PRGs controlled through ICs Controllable, addressed through implementation of health and safety plans and use of BMPs	Impacts to community longer than for Alternative B	Impacts to community longer than for Alternative D	Impacts to community longer than for Alternative E	Impacts to community longer than for Alternative F
Worker Protection	No risk to workers	Physical hazards during construction Increased accident risks from transport of materials and increased vessel traffic. Controllable, addressed through BMPs and H&S Plans.	Risk to workers for longer duration than for Alternative B	Risk to workers for longer duration than for Alternative D	Risk to workers for longer duration than for Alternative E	Risk to workers for longer duration than for Alternative F

Criteria	Alternative A	Alternative B	Alternative D	Alternative E	Alternative F	Alternative G
Environmental Impacts	No impacts to the environment due to construction activities Existing environmental impacts will continue	Ecological impacts from construction activities. Temporary loss of benthos and habitat, increased emissions from construction and transportation equipment. Exposure to contamination greater than PRGs during MNR period Controllable through BMPs, engineering control measures, emissions control strategies.	Ecological Impacts for longer period than for Alternative B	Ecological Impacts for longer period than for Alternative D	Ecological Impacts for longer period than for Alternative E	Ecological Impacts for longer period than for Alternative F
Time Until Action is Complete	Would not achieve RAOs within a reasonable timeframe	Estimated construction time ~4 years. Estimated time to achieve RAOs is uncertain, but less than for A.	Estimated construction time ~5 years. Estimated time to achieve RAOs is uncertain, but less than for B.	Estimated construction time ~7 years. Estimated time to achieve RAOs is uncertain, but less than for D.	Estimated construction time ~12 years. Estimated time to achieve RAOs is uncertain, but less than for E.	Estimated construction time ~18 years. Estimated time to achieve RAOs is uncertain, but less than for G.
Cost	Total present value (PV) cost = $0	Total = $790,870,000 (PV) Capital = $703,906,000 O&M = $0 Periodic = $337,522,000	Total = $1,105,550,000 (PV) Capital = $1,023,004,000 O&M = $0 Periodic = $460,170,000	Total = $1,490,610,000 (PV) Capital = $1,452,748,000 O&M = $0 Periodic = $651,834,000	Total = $2,053,600,000 (PV) Capital = $2,388,798,000 O&M = $0 Periodic = $803,150,000	Total = $2,446,450,000 (PV) Capital = $3,355,667,000 O&M = $0 Periodic = $977,724,000

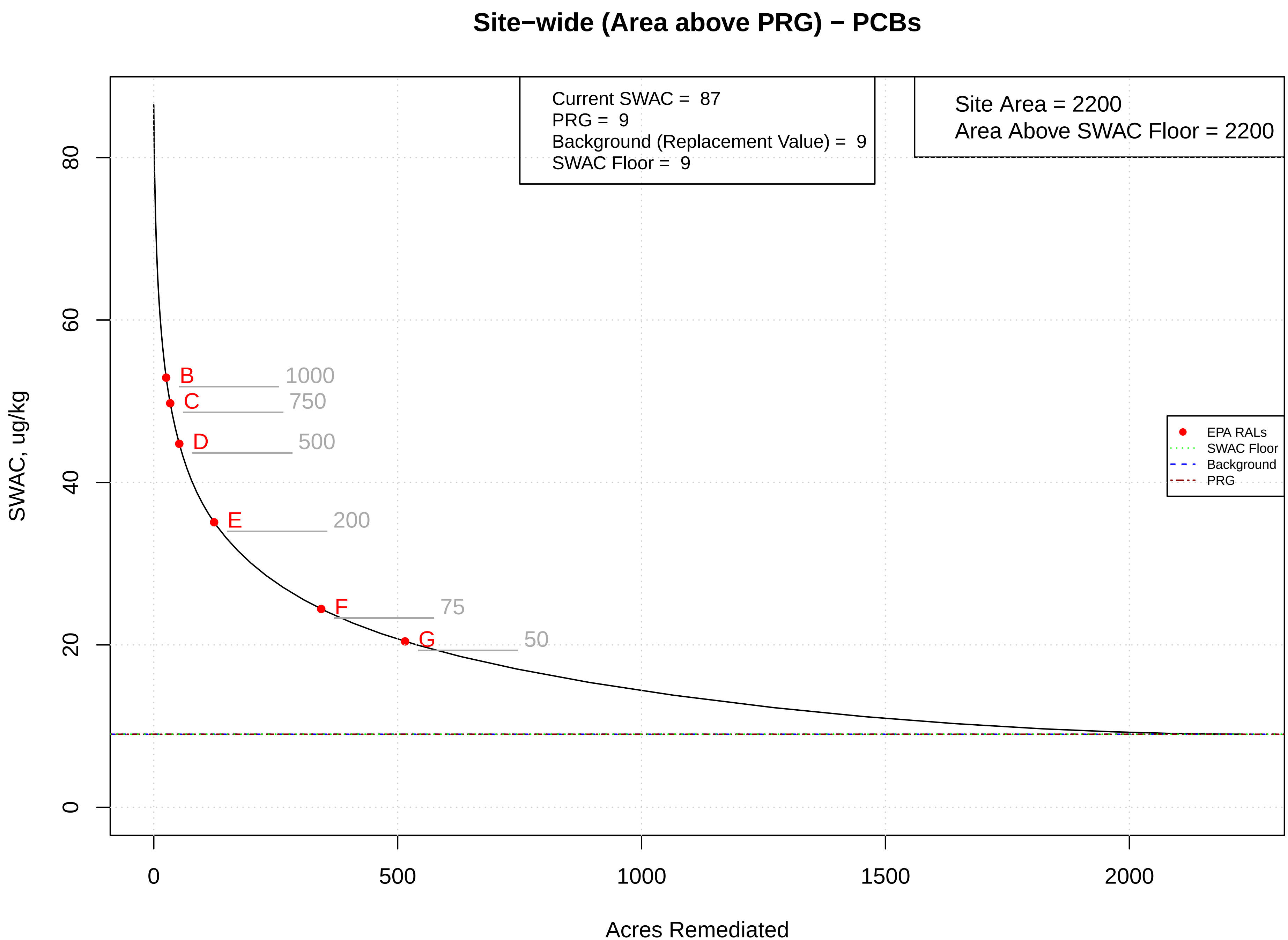

Figure 3.3-1
PCBs Site-wide RAL Curves

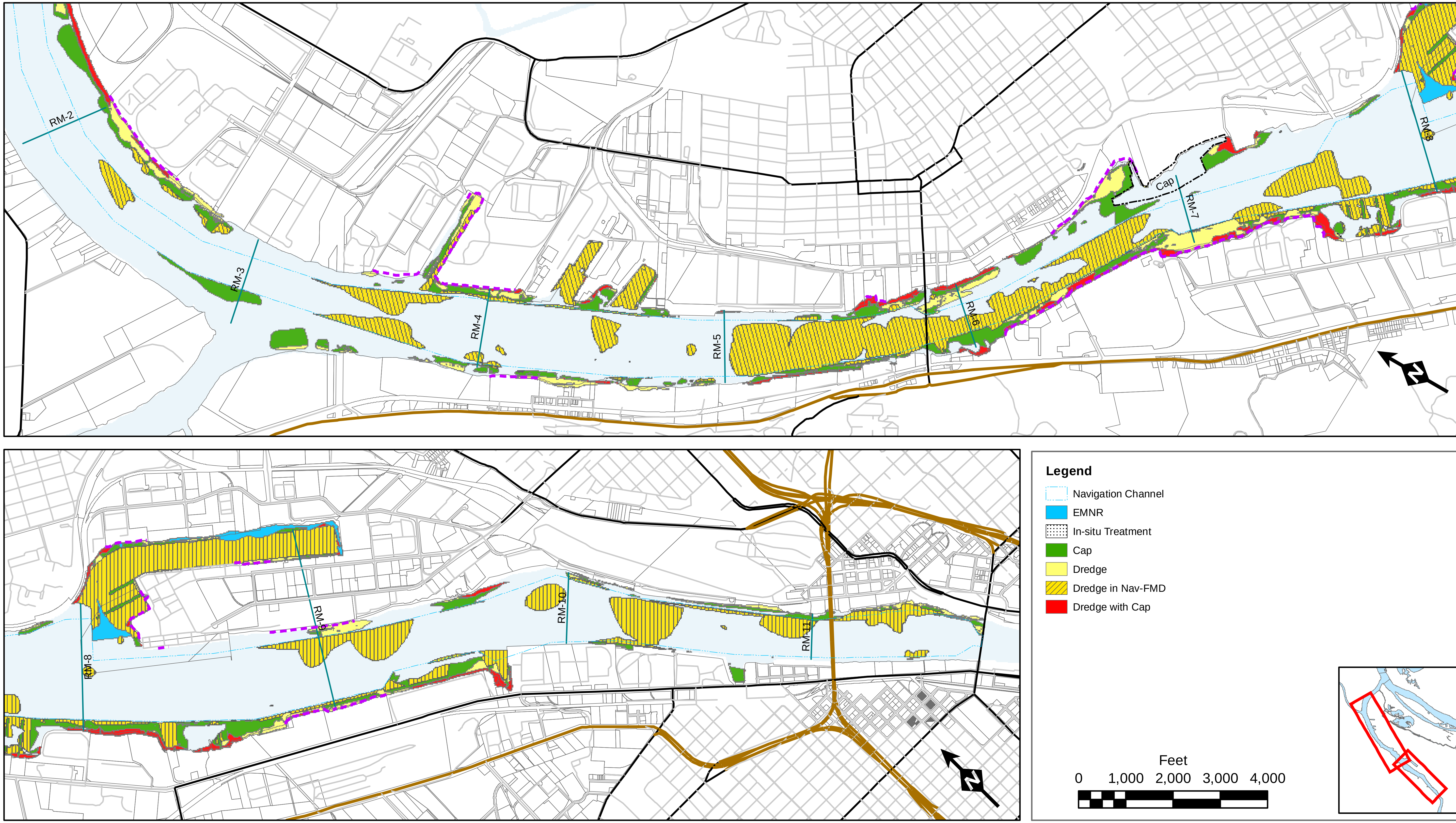

Figure 3.6-7a. Technology Assignments, Alternative G, Site-Wide

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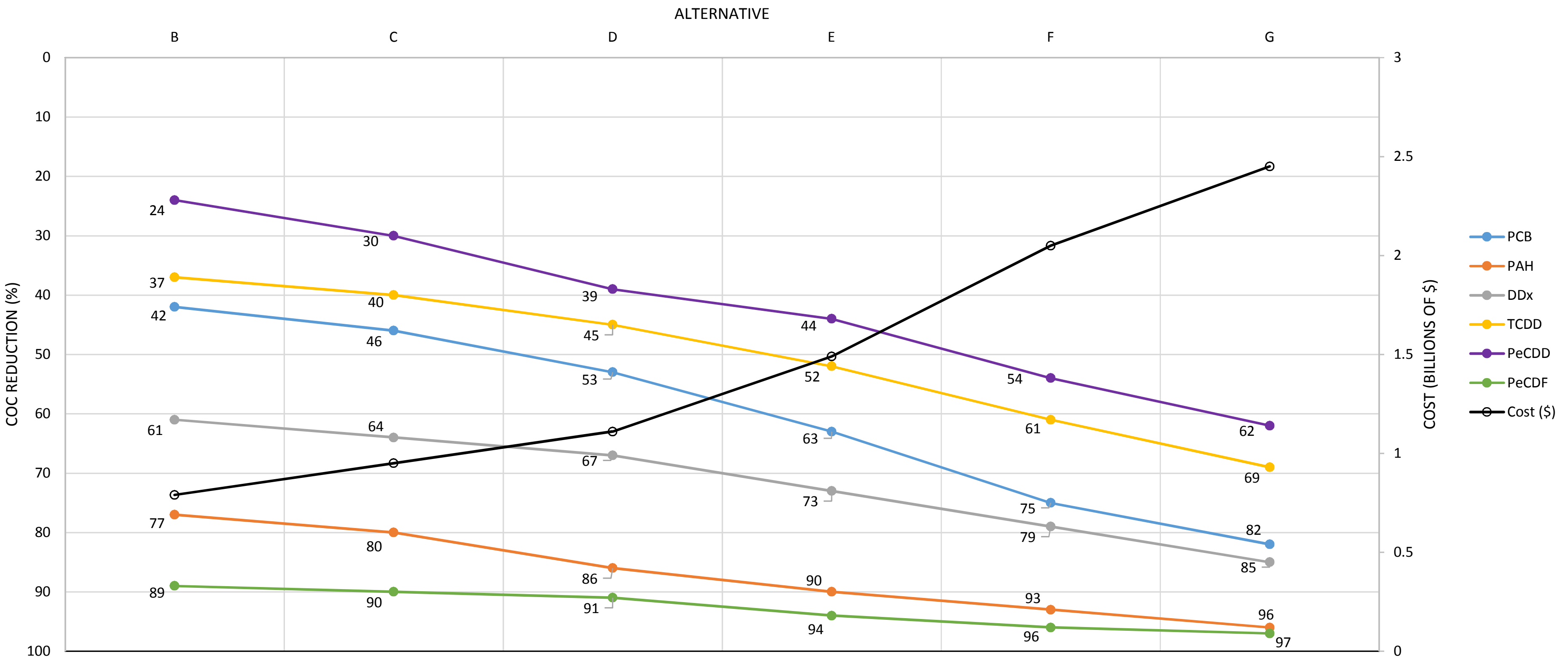
Date: 7/20/2015

Figure 1. Percent Reduction of Focused COCs and Cost for each Feasability Study Alternative



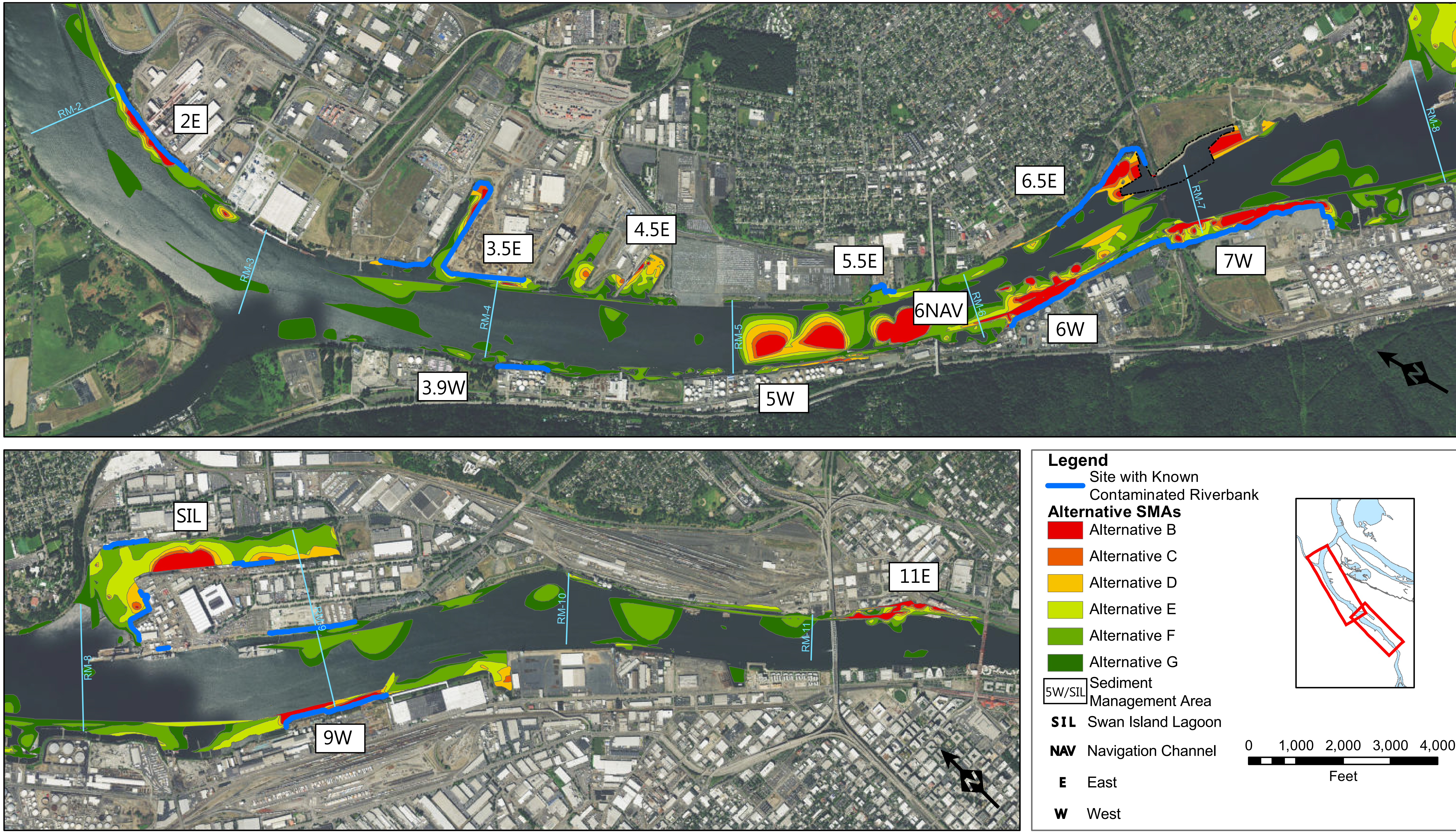


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Figure 3.3-13. Sediment Management Areas

Original Figure Source: EPA, 2015, Portland Harbor RI/FS. Draft FInal Feasibility Study Report. **Created:** 7/20/2015 **Altered**: RIDOLFI, 10/13/2015

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